Space Weather Technical Forecast

Issued on Sunday, 11 September 2022 at 13:16 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares. Active electron fluence. Possible minor geomagnetic activity midweek.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has remained Low over the past 24 hours, with X-ray activity at GOES16 and 17 again displaying occasional low-end C-class flares. These flares peaked with a C4.7 from AR3098 at 11/1033 UTC. This was one of seven sunspot groups on the disc in the period, AR3098 and two others are notable. AR3098 continued with its proliferating trend across a wide latitude. AR3100 continued to develop definition in it's trailing spot, and AR3101, which now has rudimentary penumbra around both the leading and trailing portions. The remaining four spots were small, simple or in decay.

There remain many large filaments scattered across the solar disc, though no recent lift-offs are thought to have been earth directed. Therefore, no new Earth directed CMEs have been confirmed.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, was at slightly elevated levels, between 420-490 km/s. The solar wind density was below average in single figures ppcc. The interplanetary magnetic field, IMF Bt, was weak, peaking at 6nT. The north-south component varied between +5/-5nT. The phi angle was mainly away from the Sun (positive). The net result of the above solar wind measures was Quiet to Unsettled (Kp 2-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, remained slightly above its characteristic background trace. The high energy electron flux (greater than 2 MeV) started High, peaking at 1.55e4 pfu at 10/1410UTC, before falling to moderate levels between 11/0300-0920 UTC during the diurnal minima. The 24-hour electron fluence remained above Active (1e8 integrated pfu) with a gradual declining trend, and a 11/0000 UTC observed value of 3.72e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low, but with a Chance of rising to Moderate with isolated M-class flares from either AR3098, AR3100, AR3100, or as a result of the potential return of Ex-AR3088 currently out of view near the southeastern limb.

Solar Wind / Geomagnetic Activity: The geomagnetic forecast carries low confidence. The tail of CH24/+ may give a Slight Chance of Active intervals at first, soon fading to leave mainly Quiet conditions into the start of the new working week. Confidence falls further from later Tuesday 13 September, whereupon there is a risk of CH22/- and the 09 September CME arriving, with both more likely midweek.

Energetic Particles / Solar Radiation: High energy protons (greater than 10 MeV) are expected to remain below S1/Minor radiation storm levels.

The high energy (greater than 2 MeV) electron flux is currently fluctuating between High and Moderate levels, and is Likely to remain so until midweek UTC, whereupon a combination of

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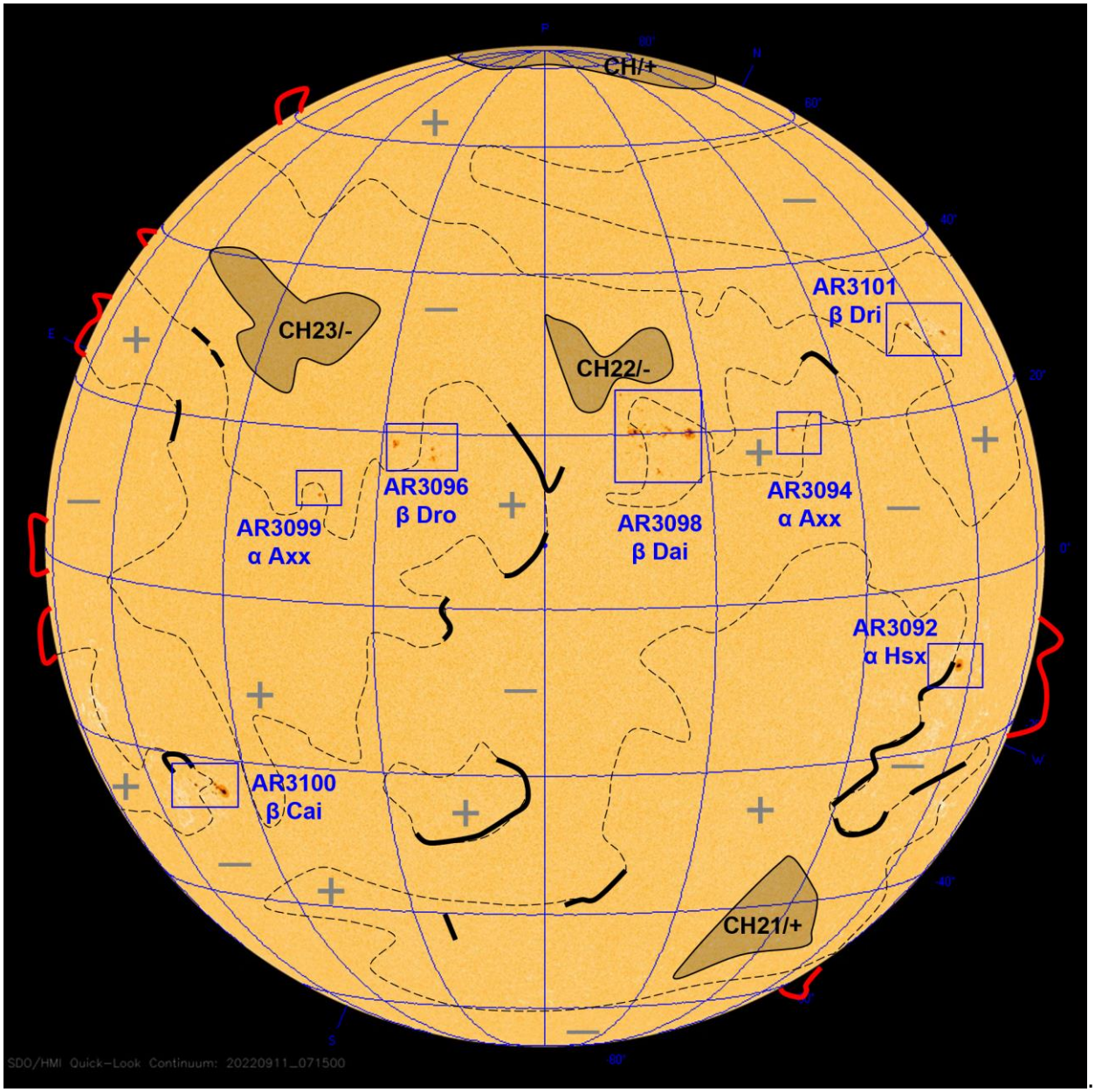
coronal hole 22 and perhaps the 09 September CME may act to redistribute electrons. The corresponding 24-hour fluence is expected to see only a gradual fall at first in the period, but likely remaining above Active (1e8 integrated pfu) until midweek.

Figure 1. Solar Analysis Valid 11/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

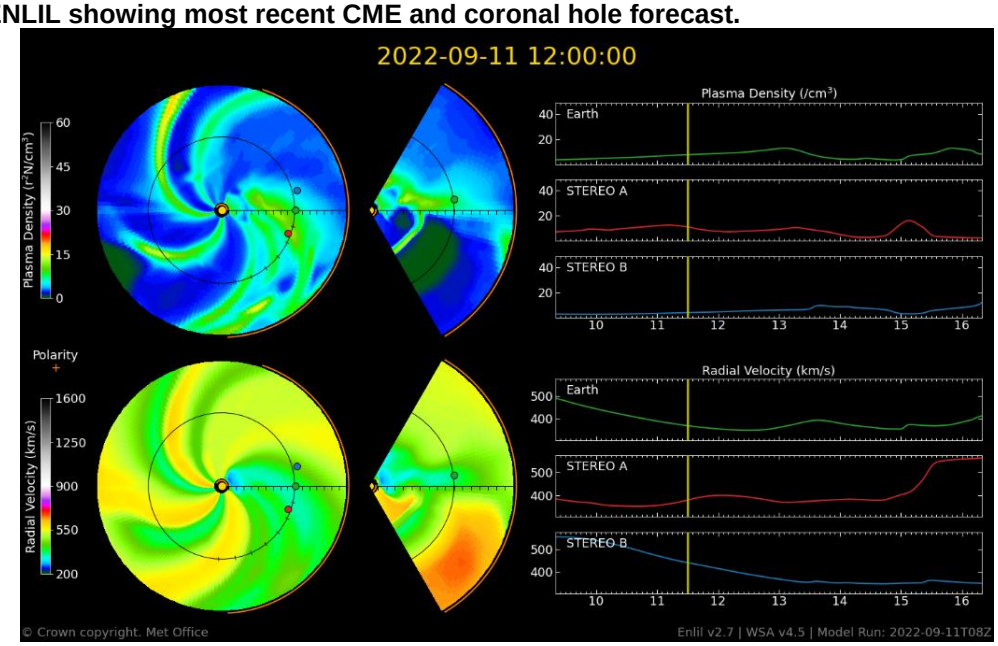
The geomagnetic forecast for the coming four-day period carries relatively low confidence, especially into the second half. The current fast wind has lasted longer than anticipated from CH20/+, and it seems likely that the faint CH24/+ is extending the long tail of activity. This should ease into the new working week UTC, with a lull then expected for a time.

The second half of the forecast period is especially low confidence, with the weak remnant successor to a very large coronal hole from last rotation (the now faint and fragmentary CH22/-) perhaps affecting Earth on Wednesday 14 September. On its own, this is not likely to be particularly potent due to its polarity and tenuous appearance, however it may be bolstered by a slow CME from 09 September. The source of this CME is not immediately apparent, but may be filament-related as there is a gap in H-alpha capability around UTC dawns at present as Udaipur is in monsoon season.

Residual influence from CH20/+ and CH24/+ should reduce through day one, Sunday 11 September: Unsettled with an initial Slight Chance of isolated Active intervals, trending to become predominantly Quiet into Monday. There is then an increasing Slight Chance of Minor Storm G1 later in the four days, peaking on Wednesday 14 September.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	5	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: ENLIL showing most recent CME and coronal hole forecast.



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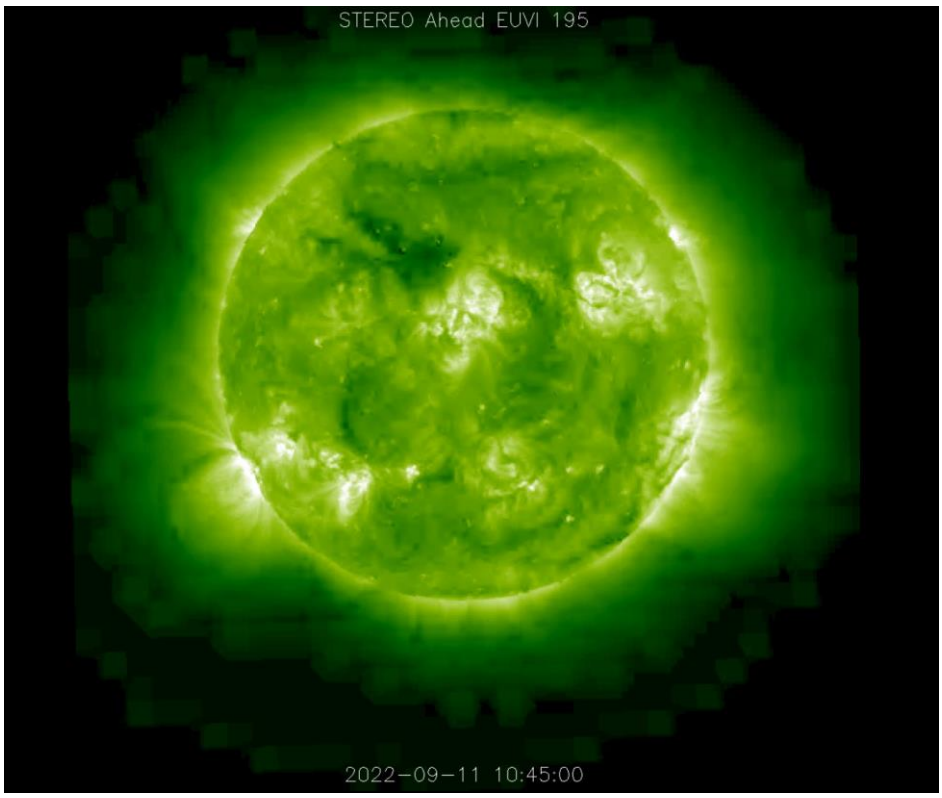
Radio Blackouts - X-Ray Flares:

There are currently seven numbered regions on the solar disc, three of which are moderately complex, these being AR3098, AR3100 and AR3101. Each of these currently only have a Slight Chance of M-class flares, though combined contribute the the Chance of an isolated M-class flare. There is also a returning region, (previously AR3088) near the southeast limb. This region is becoming evident on STEREO EVU imagery and the magnetic looping appears to be large and complex. Ex-AR3088 is due to return over the limb on day two, Monday 12 September, and was a notable region on its last-day status with numerous M-flares prior to this. The rear and east-directed CME of 08 September could also have emanated from this region. This group brings a slightly increased potential for flaring from 11 September onward. This is low confidence however, as it is uncertain how much this region has evolved during its far-side transit.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	25	30	30	30
Very Active	R3 to R5 X Class	No	2	5	5	5

Figure 3: STEREO EUVI 195 shwing bright region (Ex-3088) on the SE limb.



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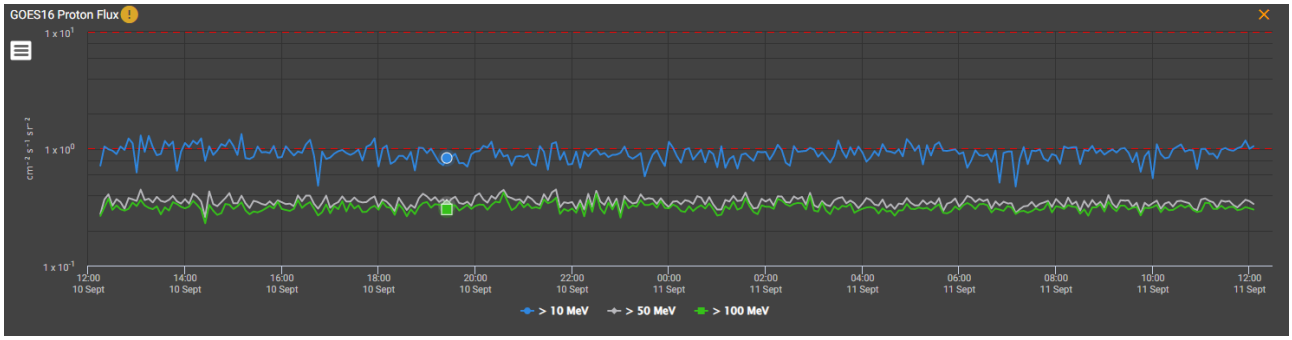
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) observed by GOES-16 remains near Background values, but with a very slight enhancement evident that appears to have now peaked.

The source of this slight increase may be tied to one of the rearward-directed limb CMEs of 08 September, with a relatively soft onset and rise seen. Whatever the source, repeats of such activity are not considered likely, and little change is expected given the lack of complex regions in geoeffective locations.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Proton trace over past 24 hours (above background).



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High Energy Electrons Event (≥ 2MeV):

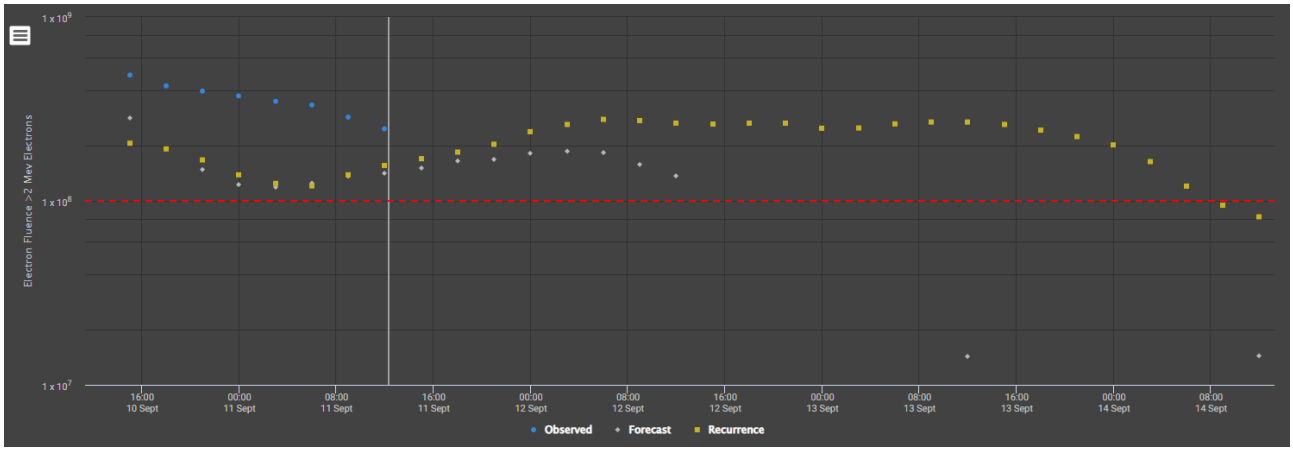
The high energy (greater than 2 MeV) electrons have shown a significant response over recent days to the long-lasting connection to coronal hole 20 fast wind, now perhaps succeeded by CH24/+. Levels are currently fluctuating between High and Moderate, and is Likely to remain so until midweek UTC, whereupon a combination of coronal hole 22 and perhaps the 09 September CME may act to redistribute electrons.

The associated 24-hour fluence levels are expected to continue gradually falling through the period, perhaps persisting above the Active threshold for much of the period, but with an increasing chance of falling below midweek UTC.

MOSWOC REFM is considered to give reasonable guidance for the overall trend through the period, though perhaps a little early in it's reduction below Active levels. The presence of at least one transient should render this forecast less reliable around the middle of the coming week.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	Yes	100	80	60	40
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: REFM model showing fluence forecast trends, observations and persistence.



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